

Blowout Jets: *Hinode* X-Ray Jets that Don't Fit the Standard Model

Ronald L. Moore, Jonathan W. Cirtain, Alphonse C. Sterling

Nearly half of all H-alpha macrospicules in polar coronal holes appear to be miniature filament eruptions (Yamauchi et al 2004, ApJ, 605, 511). This suggests that there is a large class of X-ray jets in which the jet-base magnetic arcade undergoes a blowout eruption as in a CME, instead of remaining static as in most solar X-ray jets, the standard jets that fit the model advocated by Shibata (e.g., Shibata et al 1992, PASJ, 44, L173). Along with a cartoon depicting the standard model, we present a cartoon depicting the signatures expected of blowout jets in coronal X-ray images. From *Hinode*/XRT movies and STEREO/EUVI snapshots in polar coronal holes, we present examples of (1) X-ray jets that fit the standard model, and (2) X-ray jets that do not fit the standard model but do have features appropriate for blowout jets. These features are (1) a flare arcade inside the jet-base arcade in addition to the small flare arcade (bright point) outside that standard jets have, (2) a filament of cool ($T \sim 80,000\text{K}$) plasma that erupts from the core of the jet-base arcade, and (3) an extra jet strand that should not be made by the reconnection for standard jets but could be made by reconnection between the ambient unipolar open field and the opposite-polarity leg of the filament-carrying flux-rope core field of the erupting jet-base arcade. We therefore infer that these non-standard jets are blowout jets, jets made by miniature versions of the sheared-core-arcade eruptions that make CMEs.

This work was funded by NASA's Science Mission Directorate through the Heliophysics Guest Investigators Program, the *Hinode* Project, and the Living With a Star Targeted Research and Technology Program.

Blowout Jets:

**Hinode X-Ray Jets that
Don't Fit the Standard Model**

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Abstract

Nearly half of all $H\alpha$ macrospicules in polar coronal holes appear to be miniature filament eruptions (Yamauchi et al 2004, ApJ, 605, 511). This suggests that there is a large class of X-ray jets in which the jet-base magnetic arcade undergoes a blowout eruption as in a CME, instead of remaining static as in standard solar X-ray jets, the jets that fit the reconnection model advocated by Shibata (e.g., Shibata et al 1992, PASJ, 44, L173). Along with a cartoon depicting the standard model, we present a cartoon depicting the signatures expected of blowout jets in coronal X-ray images. From *Hinode*/XRT movies and STEREO/EUVI snapshots in polar coronal holes, we present examples of (1) X-ray jets that fit the standard model, and (2) X-ray jets that do not fit the standard model but do have features appropriate for blowout jets. These features are (1) X-ray brightening inside the base arcade in addition to the outside bright point that standard jets have, (2) a filament of cool ($T \sim 80,000$ K) plasma that erupts from the core of the base arcade, and (3) an extra jet strand that appears to be rooted close to the bright point, should not be made by the reconnection for standard jets, but could be made by reconnection of the ambient unipolar open field with the opposite-polarity leg of the filament-carrying flux-rope core field of the base arcade. We therefore infer that these non-standard jets are blowout jets, jets made by miniature versions of the sheared-core-arcade eruptions that make CMEs.

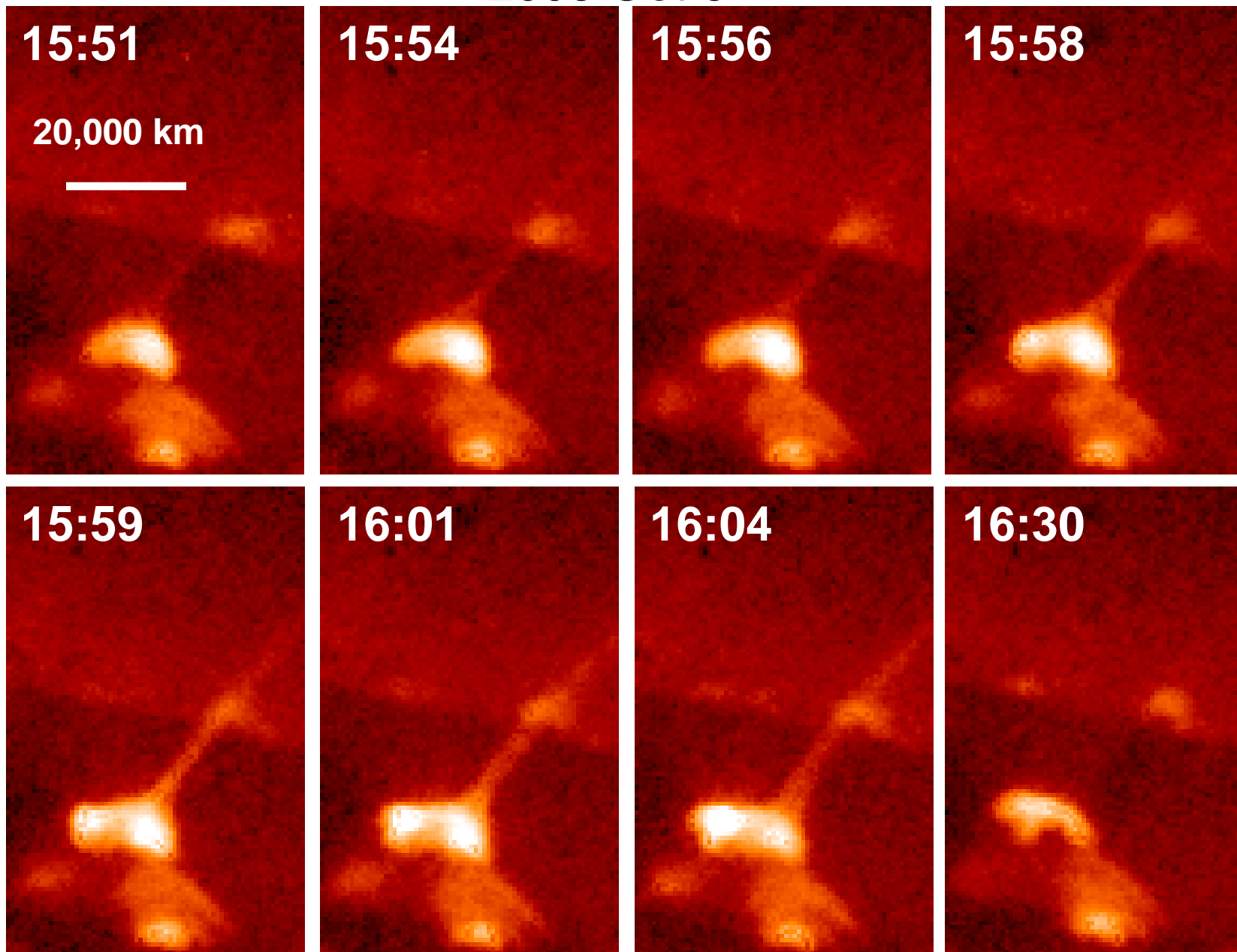
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Main Points

- *Hinode*/XRT shows two kinds of polar X-ray jets: “standard” jets and “blowout” jets.
- Standard X-ray jets fit the standard reconnection picture from Shibata and *Yohkoh*/SXT.
- Blowout X-ray jets are different:
 - Don't fit standard picture:
 - Unexplained extra jet strand.
 - Unexplained brightening inside base arcade.
 - Often eject cool EUV plasma along with the much hotter X-ray plasma.
- ⇒ Blowout jets are made by blowout eruption of the base arcade: the base arcade erupts in the manner of the sheared-core-arcade blowout eruptions that make CMEs.

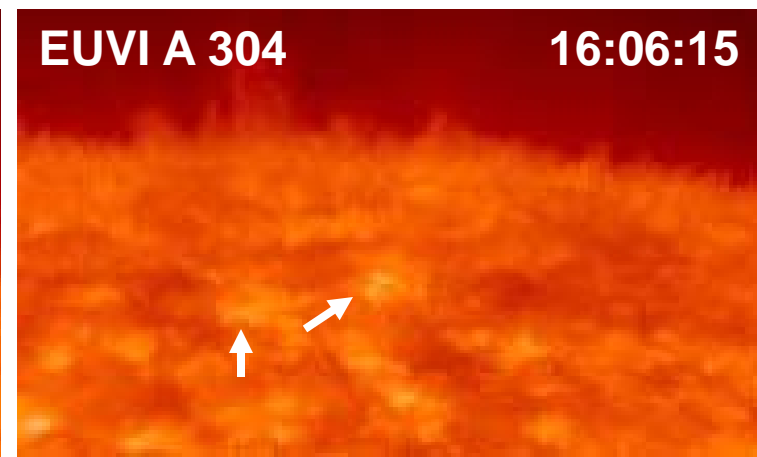
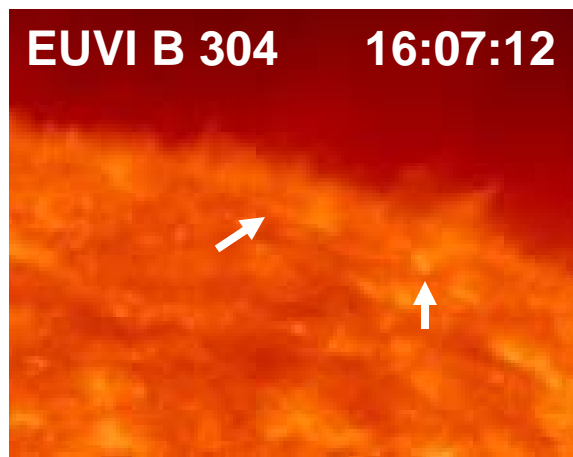
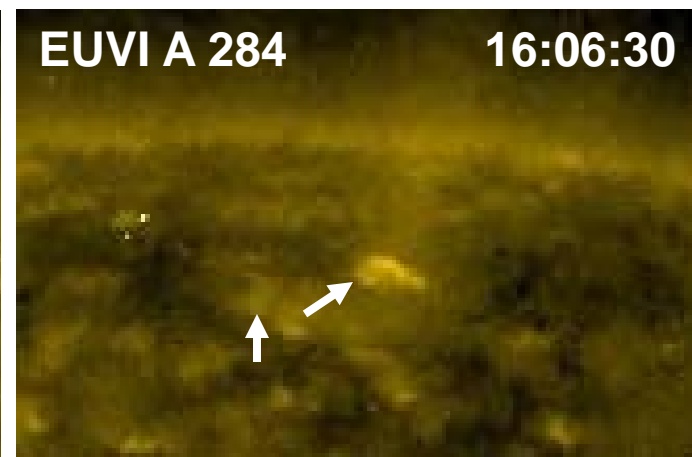
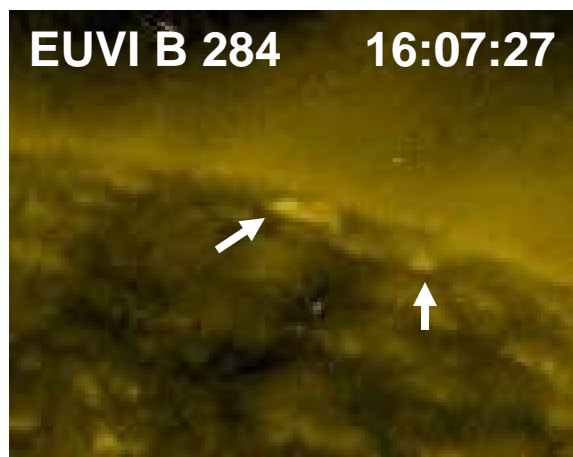
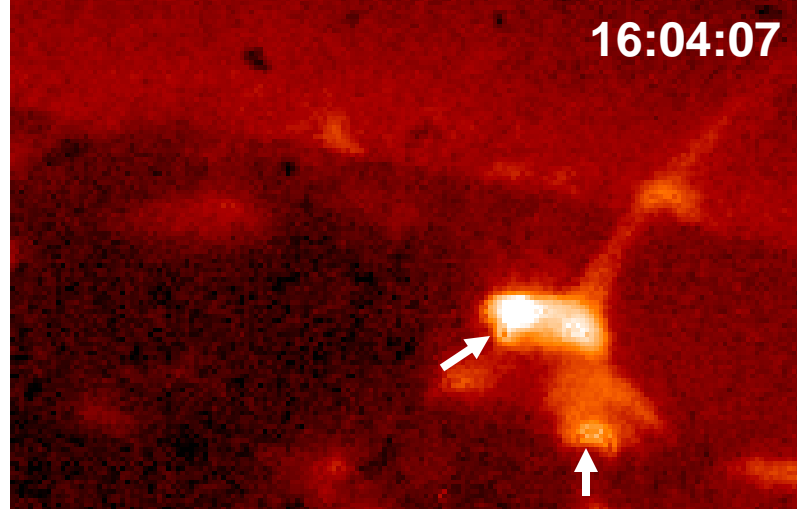
Standard Jet

2008 Oct 5



Standard Jet

2008 Oct 5

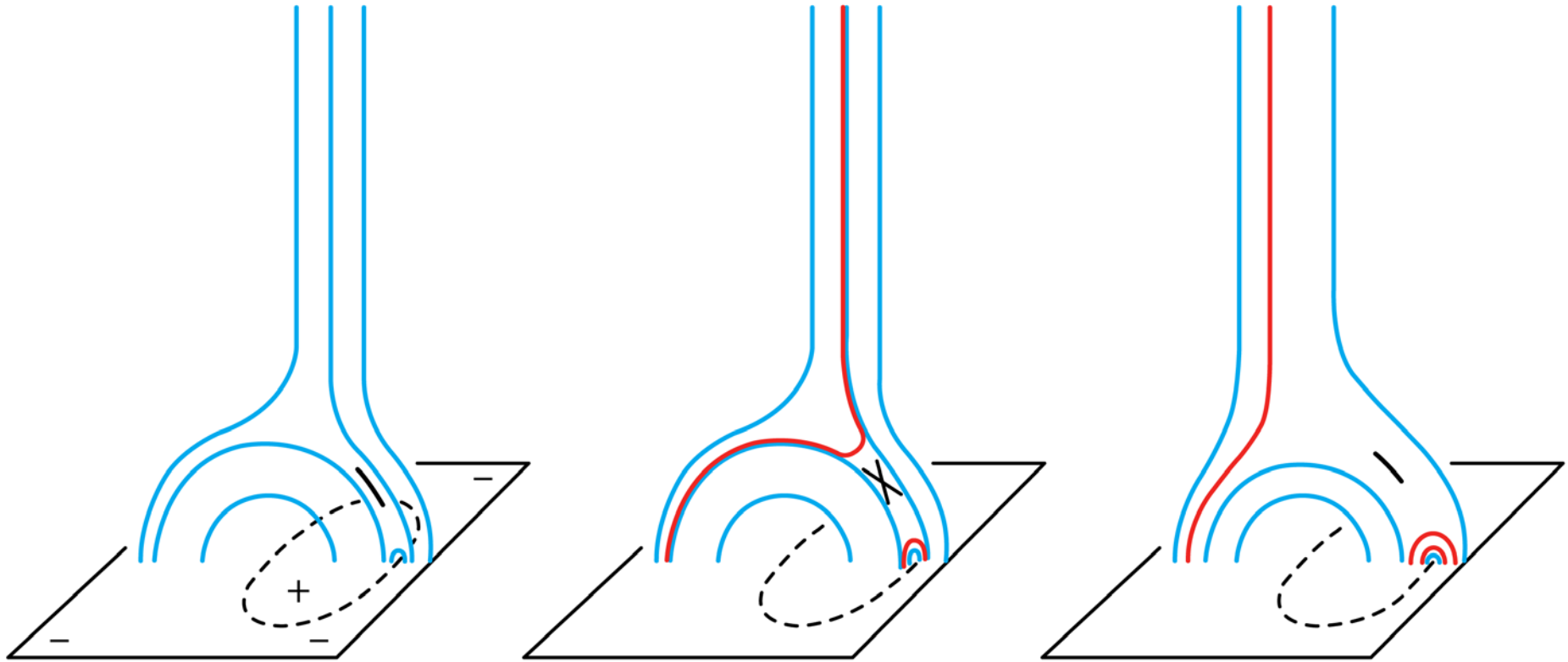


Standard X-Ray Jet Characteristics

- **Results from emergence of a magnetic arcade in surrounding high-reaching unipolar magnetic field.**
- **Single-spike, inverted-Y, Eiffel tower shape.**
- **As jet's spire turns on and grows, bright point develops at included-polarity end of base arcade.**
- **Interior of base arcade brightens slightly or dims as bright point and spire brighten and grow.**
- **As spire grows, it drifts laterally away from bright point.**

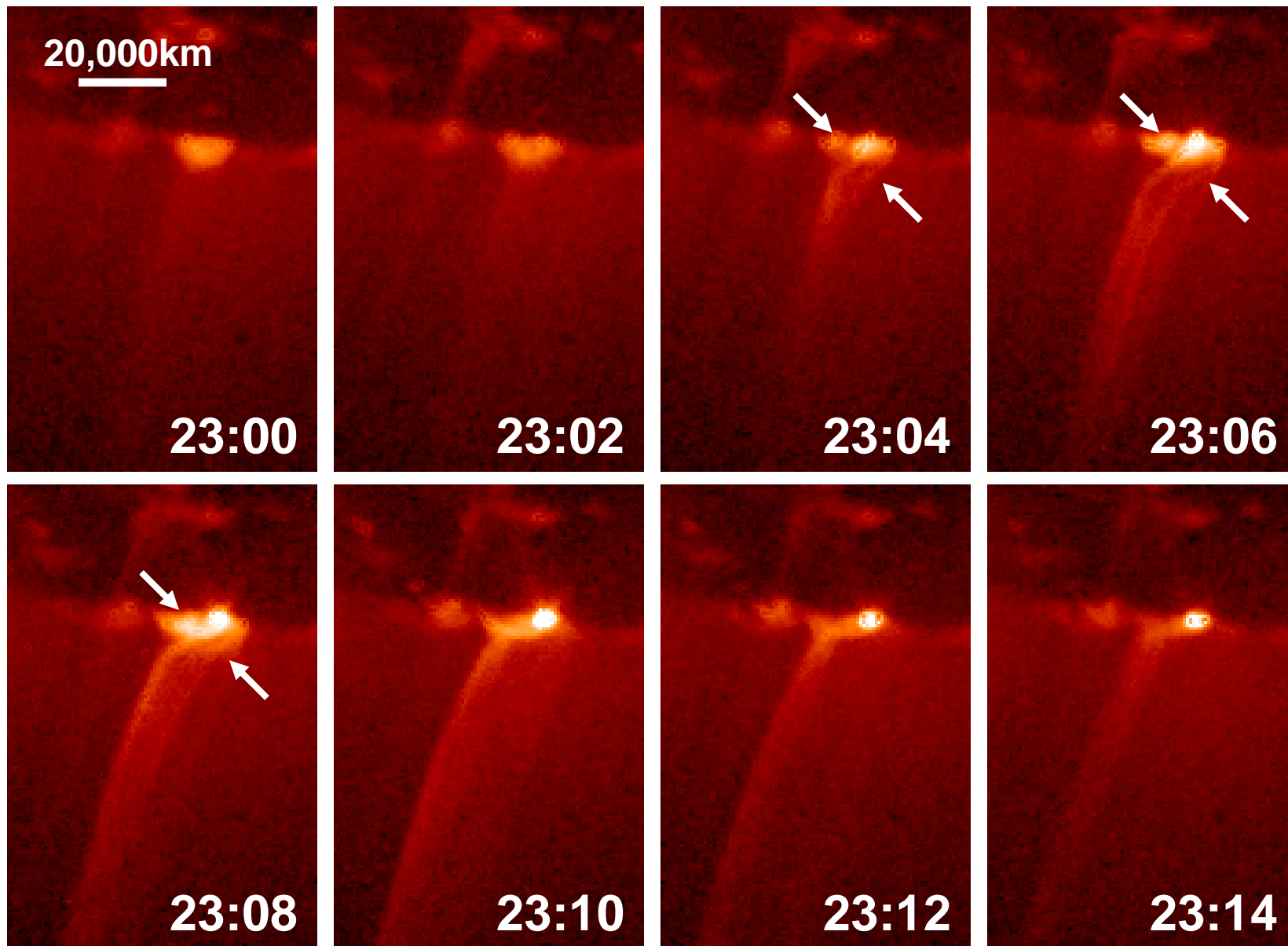
Reconnection Picture for Standard X-Ray Jets

a la Shibata et al



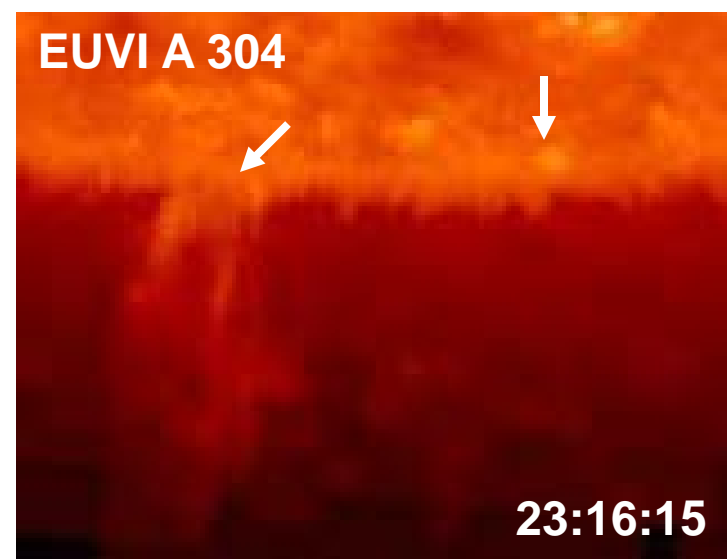
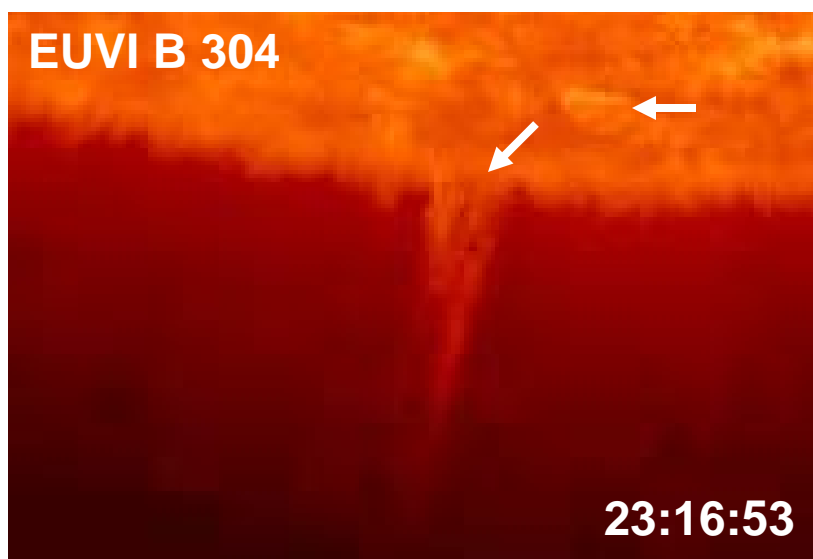
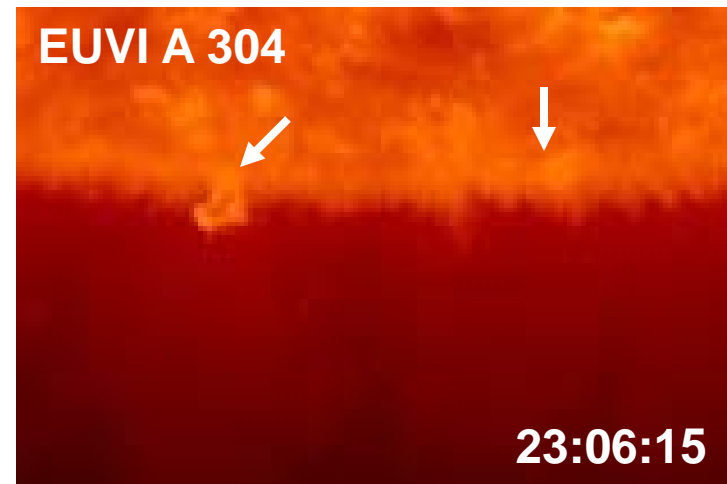
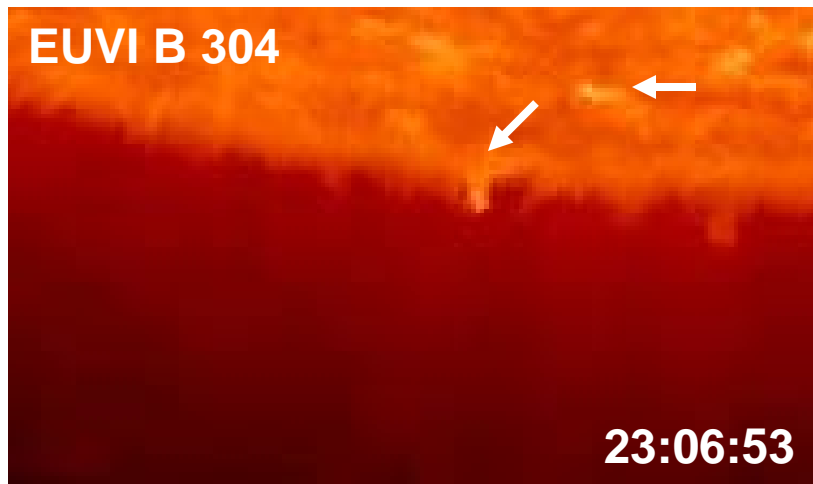
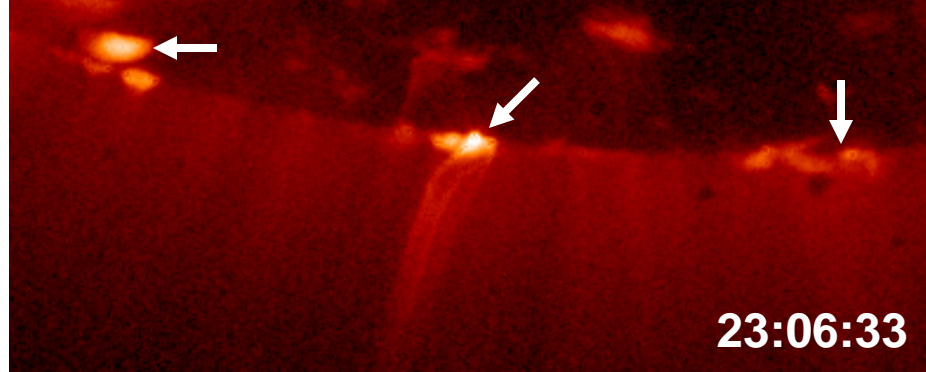
Blowout Jet

2008 Dec 4



Blowout Jet

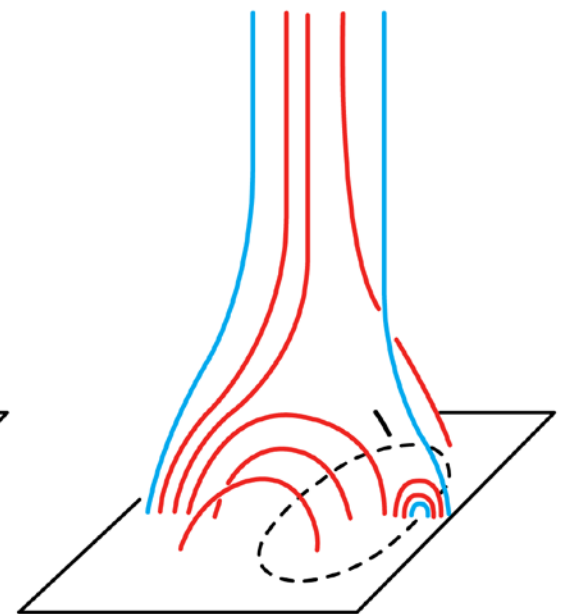
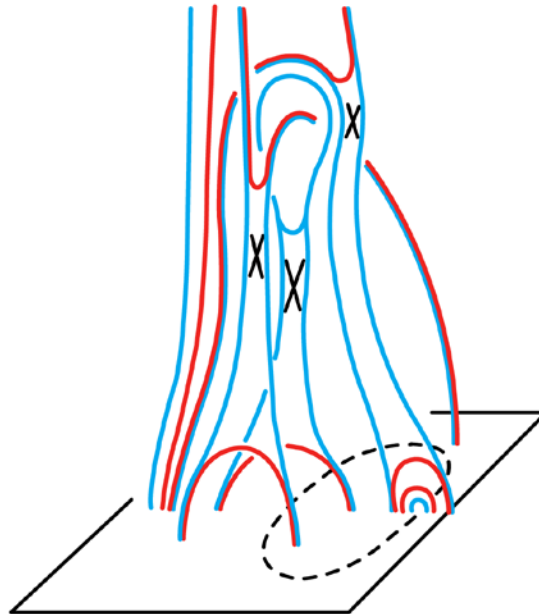
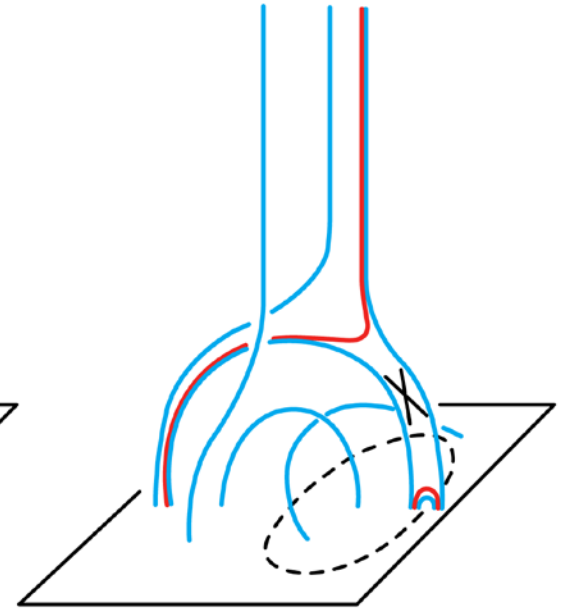
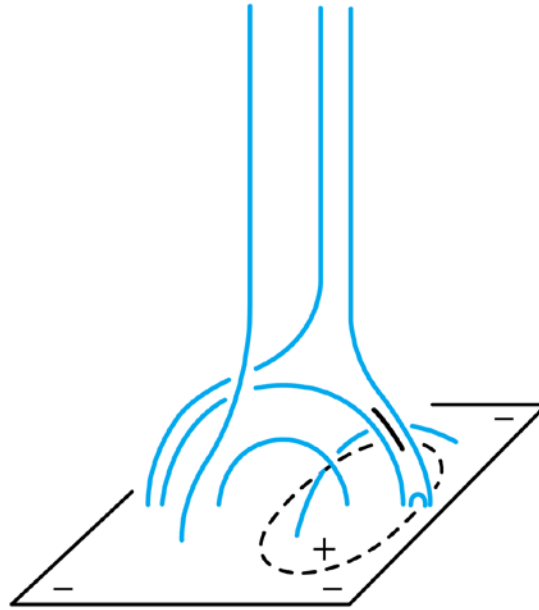
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Blowout X-Ray Jet Characteristics

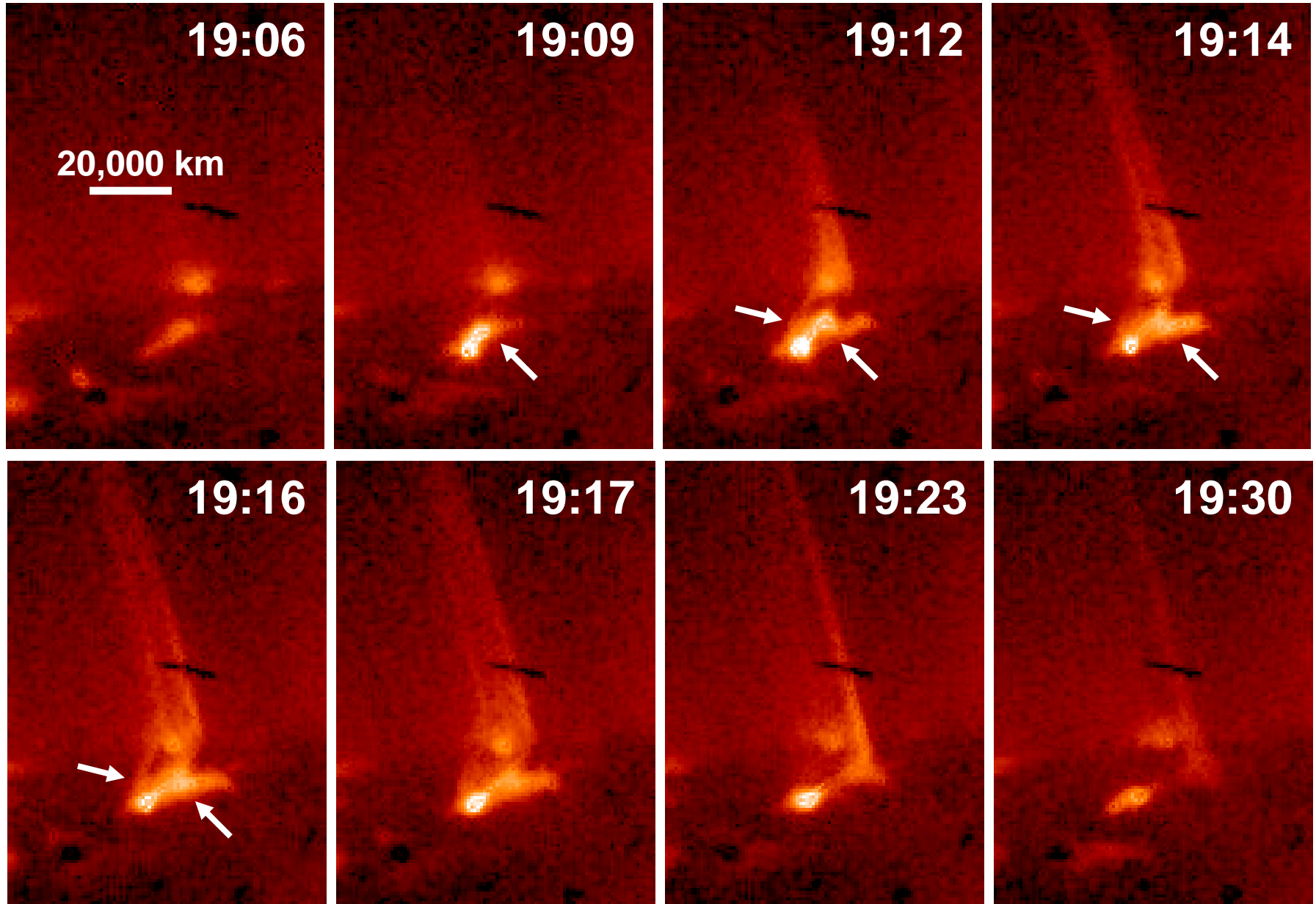
- Results from emergence of magnetic arcade in surrounding high-reaching unipolar magnetic field.
- As jet's spire grows:
 - Bright point develops at included-polarity end of base bipole.
 - **Spire has multiple strands or curtain of strands.**
 - **The strands nearest the bright point appear to contradict the standard reconnection picture.**
 - **Interior of base arcade brightens strongly.**
- As spire and bright point stop growing and fade:
 - Spire drifts laterally away from bright point.
 - Spire becomes a single-strand spire shaped like the spire of a standard jet.

Proposed Core-Field Eruption and Reconnection Picture for Blowout Jets



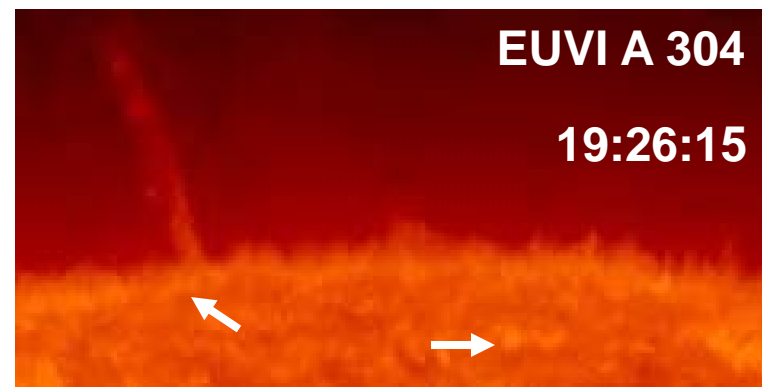
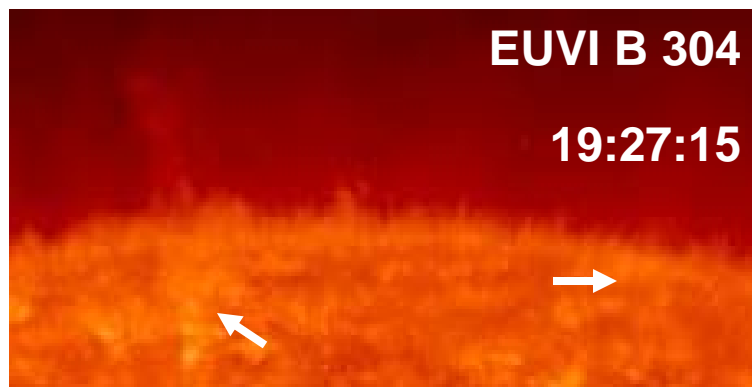
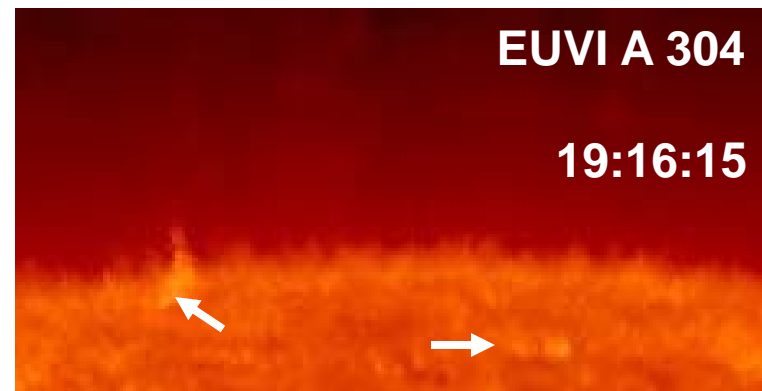
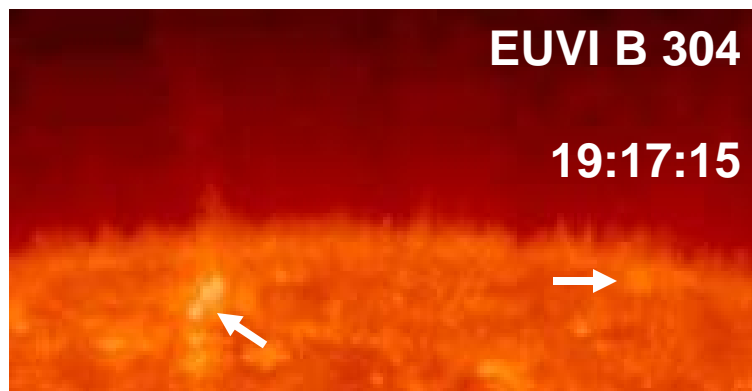
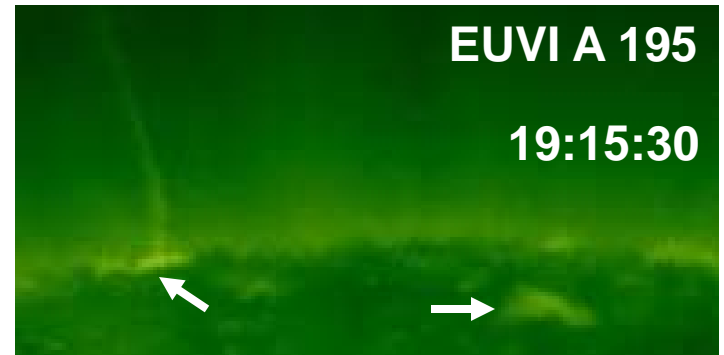
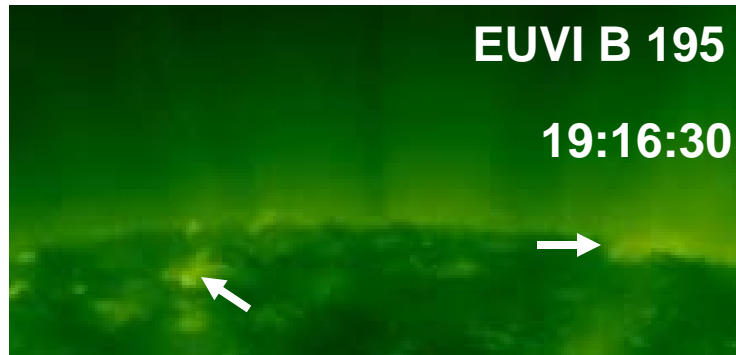
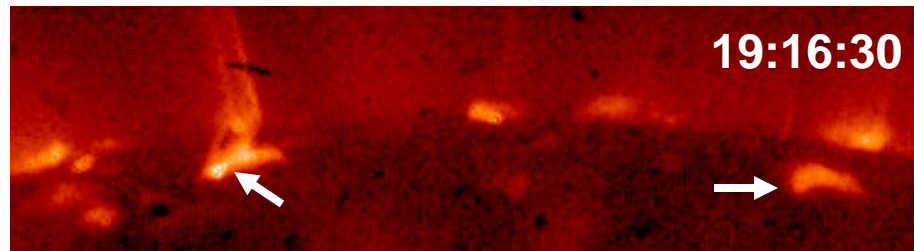
Blowout Jet

2008 Sept 20



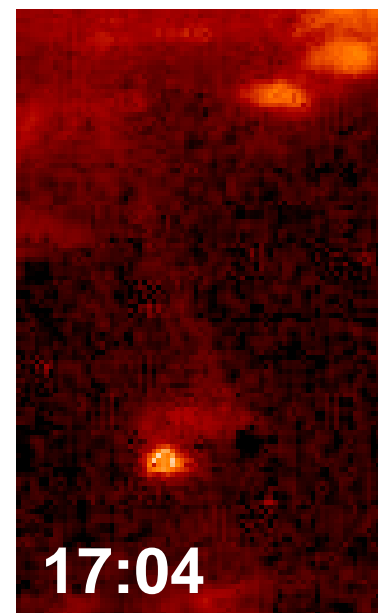
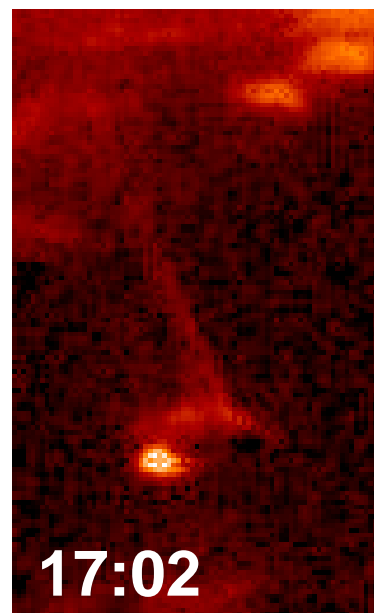
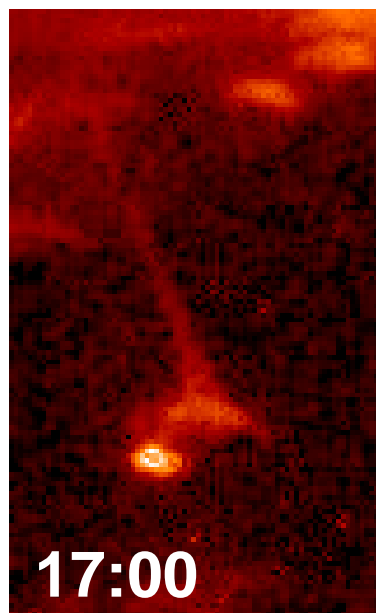
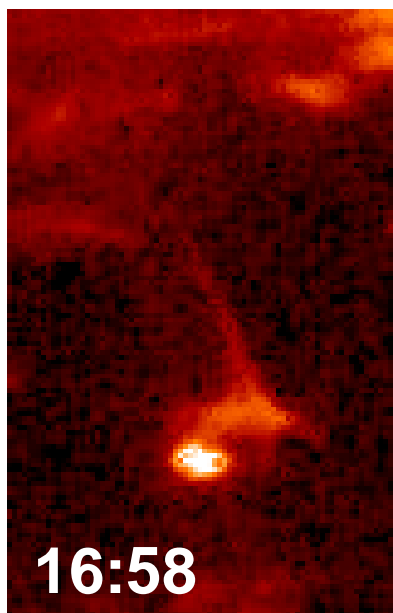
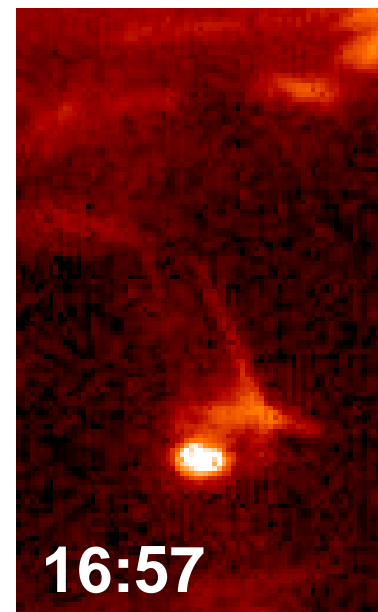
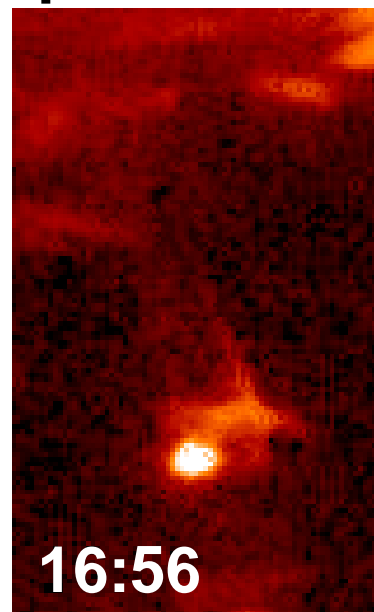
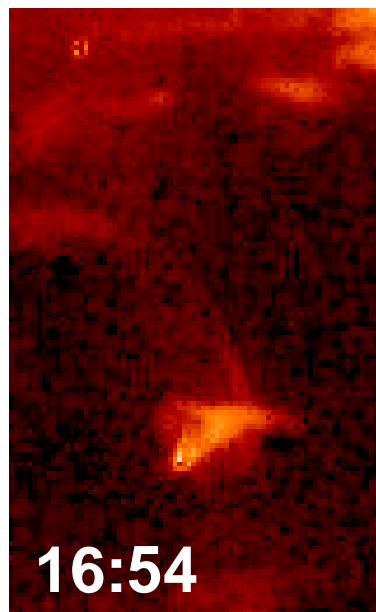
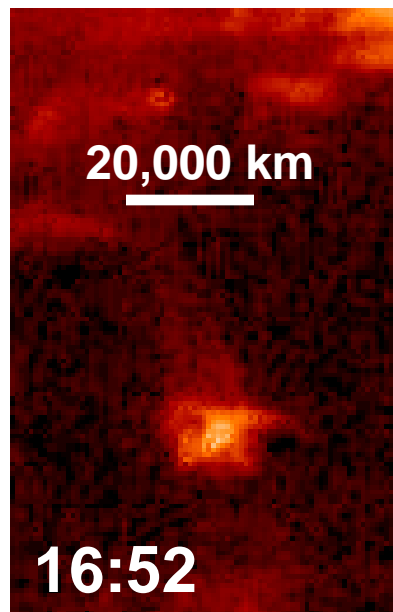
Blowout Jet

2008 Sept 20



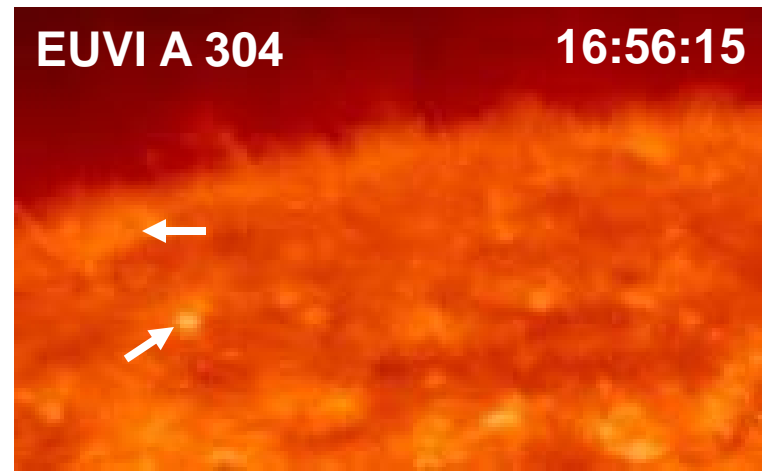
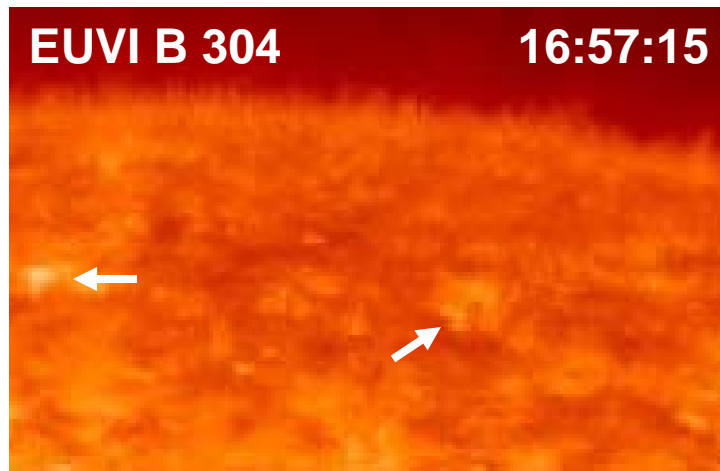
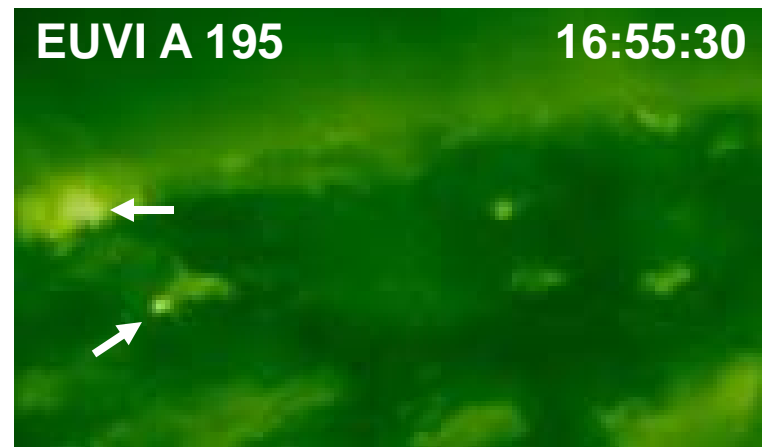
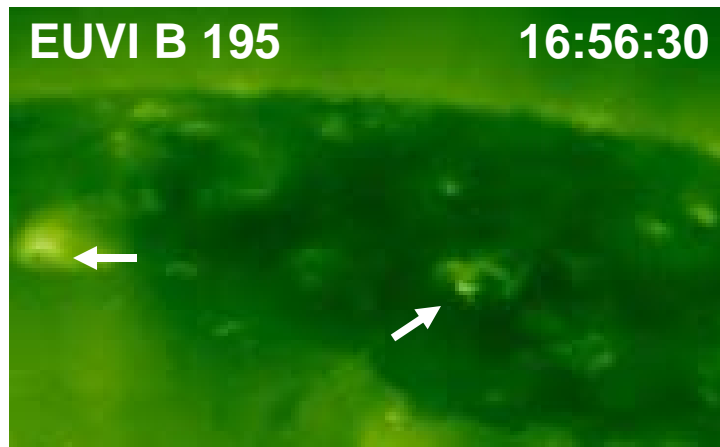
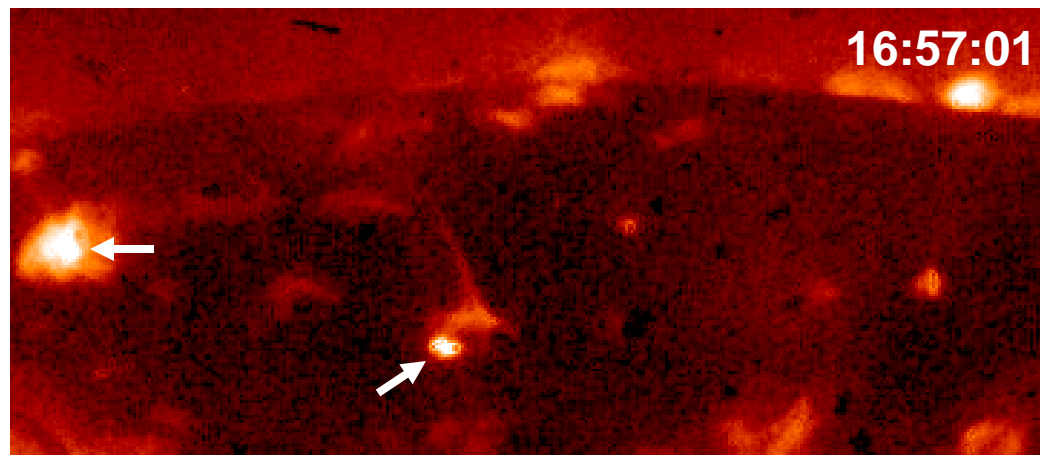
Standard Jet

2008 Sept 22



Standard Jet

2008 Sept 22



Standard Jet

2008 Dec 20

